Stochastic Optimization for Optimal Design and Operation of Quantum Devices, Algorithms, and Simulations

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QC Challenges & Opportunities $\longrightarrow$ Optimization

Key challenges for design and operation:

- Determining operational parameters for extended entanglement
- Quantum chip design
- Inherent stochasticity and noisy operation
- Algorithm design for near-term hybrid devices
- Simulation of future devices

Leverage Argonne strengths in computing & optimization

$$\underset{x \in \mathcal{D}}{\text{minimize}} \ \mathbb{E}_{\xi}\left[f(x; S(x;\xi))\right]$$

- Objective f depends on simulation (or physical system) output $S(x)$
- Derivatives of S may not be available
- Constraints defining $\mathcal{D}$ may or may not depend on S
- Dimension n is relatively small

Need specialized methods that exploit problem structure/knowledge

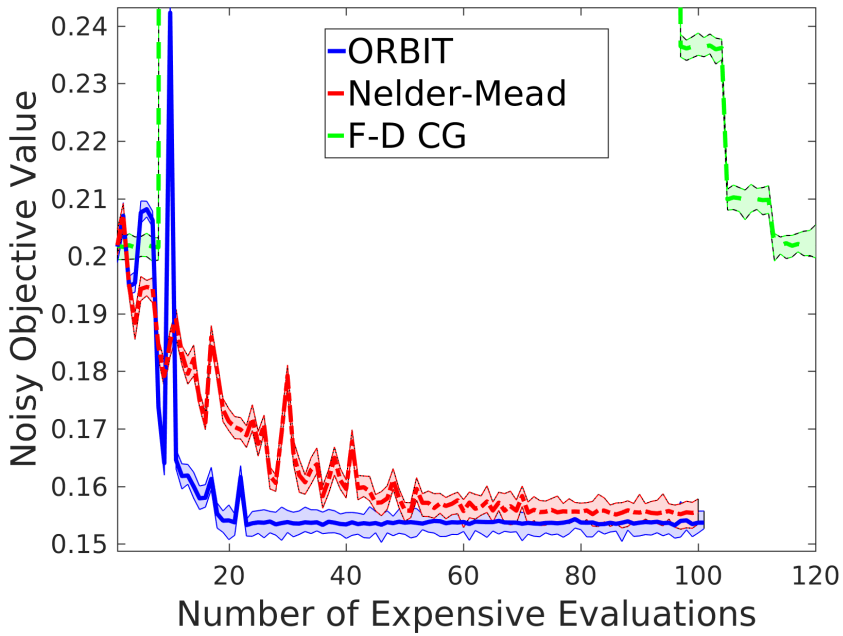
Initial Work: ASCR-Funded Quantum Algorithm Team

UCBerkeley 8-qubit device
$> 7^2$*-qubit DOE device*
expected in 2018

LBNL+ANL+UCB+Harvard project

- novel quantum chemistry algorithms
- compilation, scheduling tools
- optimization, linear algebra

to model dynamical processes in chemistry
(e.g., time dynamics quantum simulations)



Argonne's ORBIT for optimal state preparation of variational quantum eigensolver